KACO new energy.

Integration manual for blueplanet gs 92.0 - 137TL3-S

M, L, XL

Integration manual

Legal provisions

KACO warranty

For the current warranty conditions, please contact your system integrator.

Product name definitions

In this Manual the product „Grid Support Utility Interactive Inverter“ isdesignated as a device for reading reasons.

Definitions on product designations

In this Manual, the product "Grid Support Utility Interactive Inverter" is referred to as "device" for ease of reading.

Trademarks

All trademarks are recognised, even if not explicitly identified as such. A lack of identification does not mean that a product or designation/logo is free of trademarks.

Software

This device contains open source software developed by third parties and in some cases licensed under GPL and/or LGPL.

More details on this topic and a list of the open source software used, as well as the corresponding licence texts, can be found in the web interface information display under "Licence List".

Integration manual

Bidirectional feed-in inverter

Table of contents

1 General information

1.1 Scope

As the core of an battery energy storage system (BESS), the bi-directional feed-in inverter blueplanet 92.0 - 137TL3-S can be used to realise a wealth of potential applications, such as self-consumption optimisation, primary control capacity, peak-shaving and multi-use applications in a flexible manner.

The following preconditions must be met before the device can be used in an BESS:

1. 1. The DC voltage range of the battery used must suit the input voltage range of the device.
2. The device must be integrated into the energy management system (EMS) of the BESS in a communicative sense.

These integration instructions are intended to assist you in integrating the device into an BESS with an energy management system (EMS).

1.2 About this document

This document is valid for the following types of device from firmware version V3.64 onwards

Typenbezeichnung *[KACO Art. Nr.]*	BLUEPLANET GS 92.0 TL3-S B1 WM OD IIGM	[1001912]
	BLUEPLANET GS 92.0 TL3-S B1 WM OD IIGL	[1001910]
	BLUEPLANET GS 92.0 TL3-S B1 WM OD IIGX	[1001911]
	BLUEPLANET GS 110 TL3-S B1 WM OD IIKM	[1002020]
	BLUEPLANET GS 110 TL3-S B1 WM OD IIKL	[1002021]
	BLUEPLANET GS 110 TL3-S B1 WM OD IIKX	[1002022]
	BLUEPLANET GS 137 TL3-S B1 WM OD IIPM	[1002014]
	BLUEPLANET GS 137 TL3-S B1 WM OD IIPL	[1002013]
	BLUEPLANET GS 137 TL3-S B1 WM OD IIPX	[1002012]

1.3 More information

Links to more detailed information can be found at www.kaco-newenergy.com

Document title	Type of document
Technical data sheet	Product flyer
Modbus protocol	Application note (EN)
SunSpec Information Model Reference SunSpec Information Model Reference KACO	Available from the KACO new energy sales team pv-projects.kaco.de@siemens.com
Software package	Files on current software
KACO SunSpec Client LIGHT	Tool for reading out the SunSpec models to read out the addresses in the Start Register.
KACO Manual	Operating instructions

NOTE: Not all documents regarding this device are available online.

1.4 Target group

All activities described in the document may only be carried out by specially trained personnel with the following qualifications:

- Knowledge on the function and operation of a bidirectional feed-in inverter
- Knowledge about IP-based network protocols
- Knowledge of the modbus specifications
- Knowledge of the SunSpec modbus specifications
- Education concerning the installation and configuration of IT systems
- Training in the handling of hazards and risks during the installation and operation of electrical units and plants.
- Education concerning the installation and start-up of electrical units and plants.
- Knowledge of applicable standards and directives.
- Knowledge and adherence to this document with all safety notices.

2 Supply line and fuse requirements

3 Battery Energy Storage System

3.1 BESS configuration

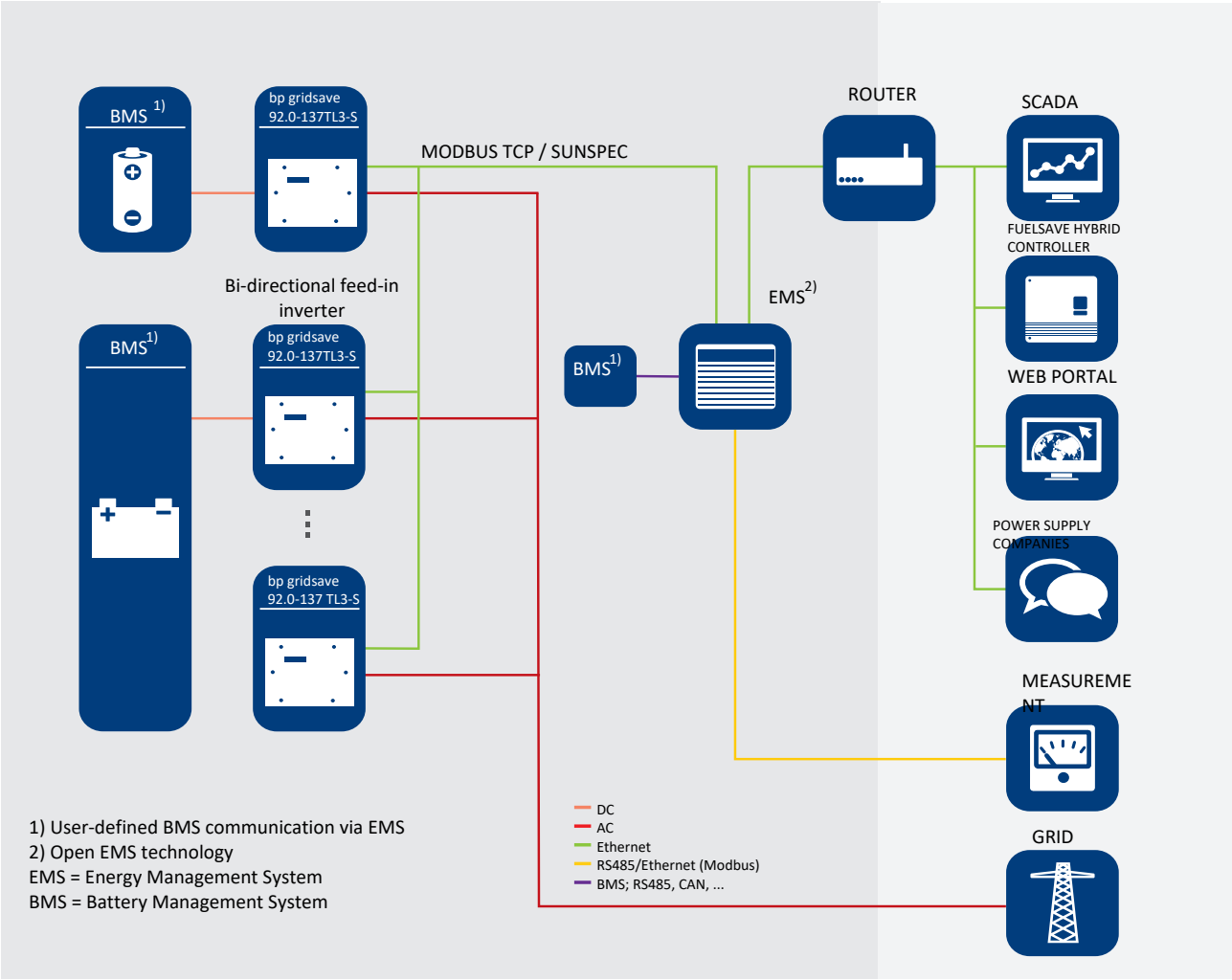


Fig. 1: System overview - integrating the bi-directional feed-in inverter

The graphic [See figure 1] [▶ Page 5] shows the general configuration of an BESS. The following components are found in most BESSs in addition to the device:

- Energy storage unit (e.g. Li-Ion battery with a battery management system (BMS)).
- Measuring point for measuring voltage, current etc.
- Router
- EMS/PMS

These components are linked to the EMS in a communicative sense. The EMS is responsible for system regulation and thus regulates the flow of energy and power in the BESS in accordance with the application and system status.

3.2 Size of the BESS

When using a single unit, 92 kVA , 110 kVA or 137 kVA are available depending on the power class.

To increase the power, several devices can be connected in parallel both exclusively on the AC side and on the AC and DC sides. The capacity (energy content) of the battery has no influence on the number of devices required.

Additional communication between devices operated in parallel is not required in either case.

3.2.1 AC parallel connection only

Any number of devices can be connected in parallel on the AC side and thus the output power of the BESS can be scaled as large as required in steps according to their power class.

3.2.2 AC and DC parallel connection

NOTE

Conditions necessary for DC parallel operation:

› In case of a DC parallel connection of more than 2 devices, consultation with KACO new energy is required.

› Same power specification for all active devices in DC parallel operation.

› Identical firmware version on all devices.

The first benefit of a DC parallel connection - i.e. operating multiple devices on a single battery - is that the battery can be operated at higher C-rates when the max. charging and discharging capacities of the devices are increased, and the second benefit is that a greater degree of efficiency can be achieved in the partial load range by way of switching off unnecessary devices.

Up to 2 devices can be connected in parallel on the DC side. Scaling using >2 devices is possible in consultation with KACO new energy.

3.3 Selecting the battery

3.3.1 Minimum DC voltage

The device is what is referred to as a "one-step" device and is characterized by the fact that, in favor of a greater degree of efficiency, a DC-DC actuator has not been included. Such a DC-DC actuator could adjust the input voltage to the level required for mains infeed. This min. voltage level requirement depends on the AC voltage level (U_{AC}) at that time. As such, the given DC voltage level must always be higher than this U_{AC} dependent rectified value.

Required parameters:

U_{AC} -> Effective value of the phase-N voltage

[1] $U_{DCminStart}$ -> Minimum DC voltage required to start up the inverter.

[1] $U_{DCminOperation}$ -> minimum DC voltage during operation of the device.

Calculation

- $U_{DCminStart}$ [1]
  - describes the minimum DC voltage that must be present when connecting to the Grid.
  - is calculated from:
    - $U_{DCminStart}$ = $U_{ACOperation}$ x 2,91 (for blueplanet gridsave 92.0 TL3-S - 668V / 230V)
    - $U_{DCminStart}$ = $U_{ACOperation}$ x 2,91 (for blueplanet gridsave 110 TL3- S - 801V / 277V)
    - $U_{DCminStart}$ = $U_{ACOperation}$ x 2,91 (for blueplanet gridsave 137 TL3- S - 1002V / 346V)
  - If the battery voltage is too low compared to the AC voltage (U_{DC} < U_{AC}* 2,91) the device goes into the error state with status after a waiting time of approx. 120s. `225 („Battery voltage too low to switch on“)` Status_Fehlermeldungen. Switching on when the DC voltage is too low is not possible.
- $U_{DCminOperation}$ [1]
  - Corresponds as a rule $U_{DCminStart}$. This depends on the maximum level of AC overvoltage required for operation („FaultRideThrough“). FRT [See section 6.6.3 Page 26]
  - If only operation at a lower AC overvoltage is required, it is be possible to have $U_{DCminOperation}$ lower than $U_{DCminStart}$.
  - **NOTE: If the DC voltage level drops below a value of UDCminStart reactivation is no longer possible after a shutdown. Therefore KACO advises against using this range.** [1]
  - in addition to the AC voltage level, it is dependent on the country-specific grid connection conditions which, in addition to fixed permissible voltage tolerances, may also stipulate continuous operation of the device up to a specified overvoltage level.
  - In the modifiable country-specific settings for the device, the default setting for $U_{DCminOperation}$ sensures that these requirements are met. FRT [See section 6.6.3 Page 26]

NOTE: uring the configuration phase and during operation, keep in mind that the given AC voltage level is subject to the permissible tolerances.

[1] As of SW >3.62 the distinction between $U_{DCStart}$ and $U_{DCOperation}$no longer applies. Do not follow the marked sections.

3.3.2 Maximum DC voltage

The maximum input voltage allowed for operation is 1315Vdc. However, it should be noted that derating occurs at high DC voltages and high heat sink temperatures.

Derating at low heat sink temperatures and high voltages.

The following graphics shows the derating behaviour subject to the heat sink temperature at high voltage levels. The heat sink warms up during operation subject to duration and load. However, at low temperatures, it is cooled down again by the fan. As such, it is not possible to describe outside temperature-dependent behavior. Instead, this should be tested in a real-life environment..

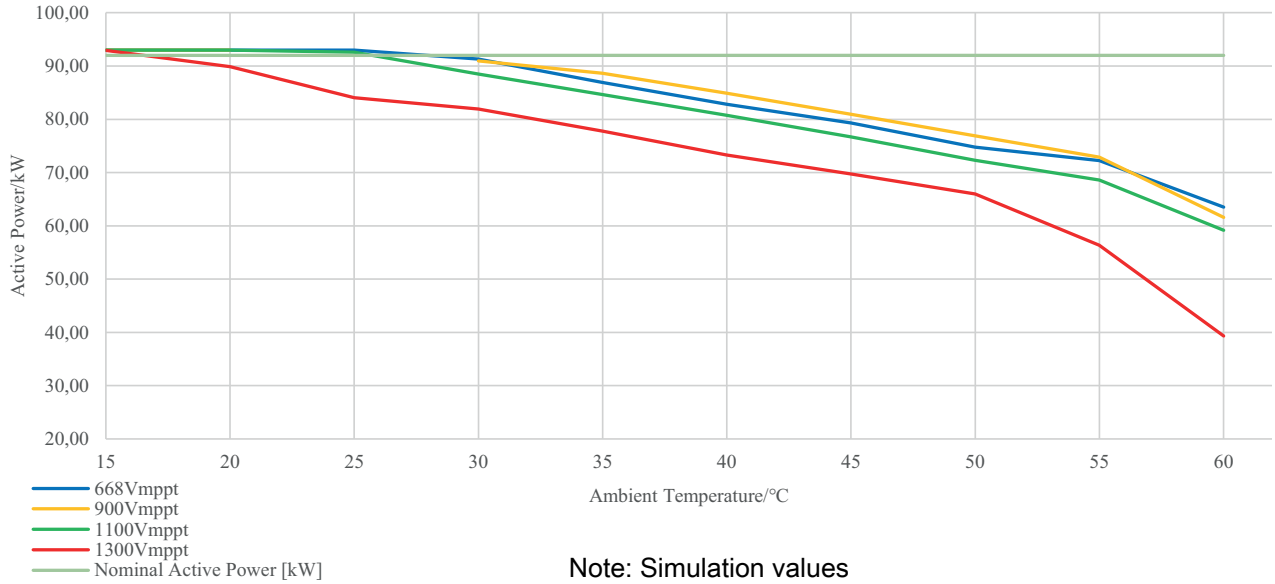


Fig. 2: Mean value of active power at different temperatures with different DC voltages in charging mode – blueplanet gridsave 92.0TL3-S

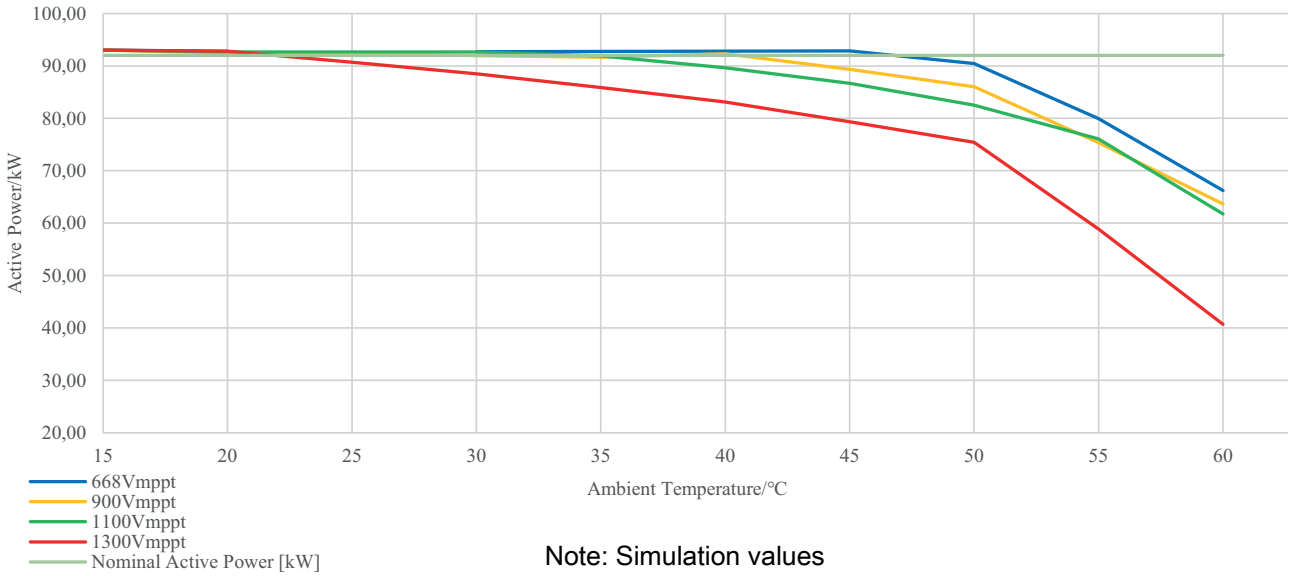
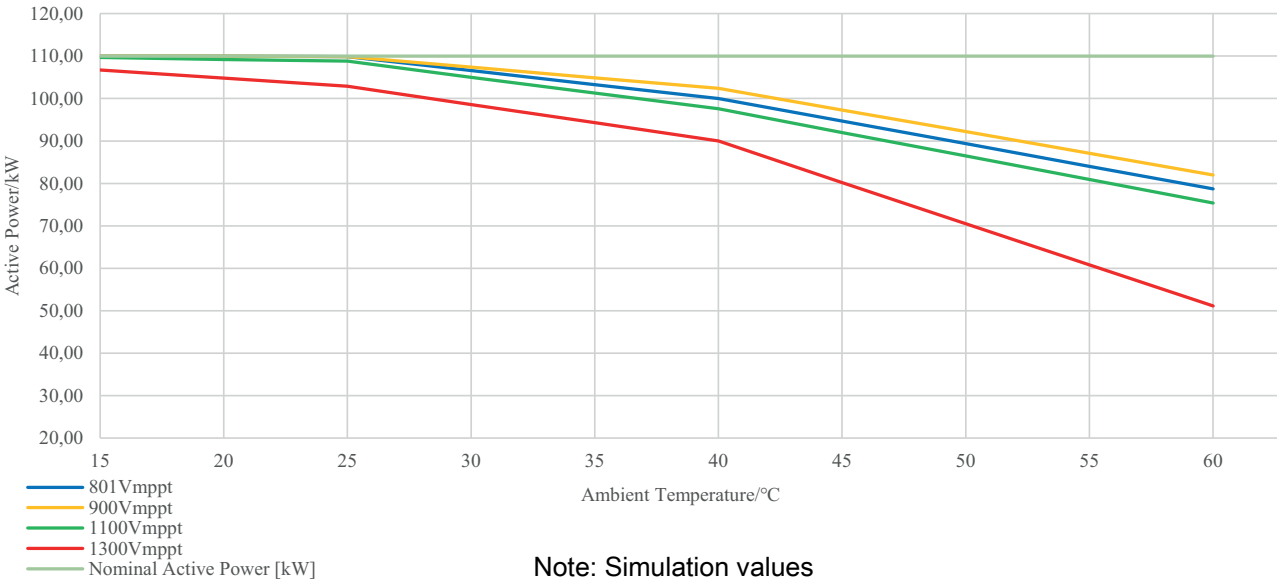
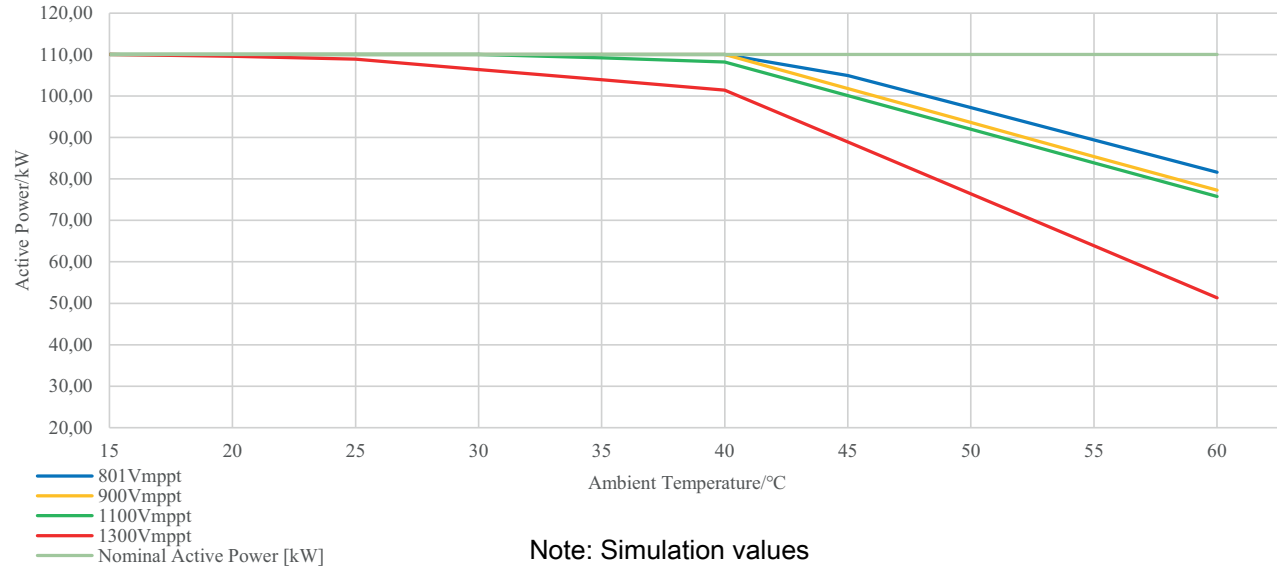


Fig. 3: Average value of active power at different temperatures with different DC voltages in discharge mode – blueplanet gridsave 92.0TL3-S



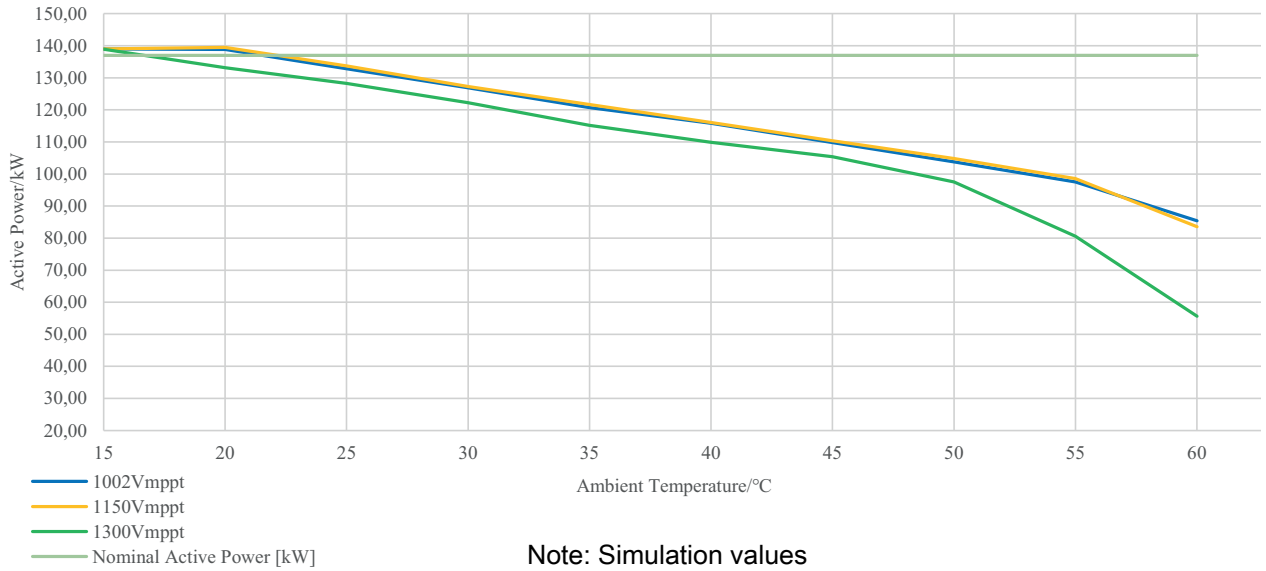
Note: Simulation values

Fig. 4: Mean value of active power at different temperatures with different DC voltages in charging mode – blueplanet gridsave 110.0TL3-S



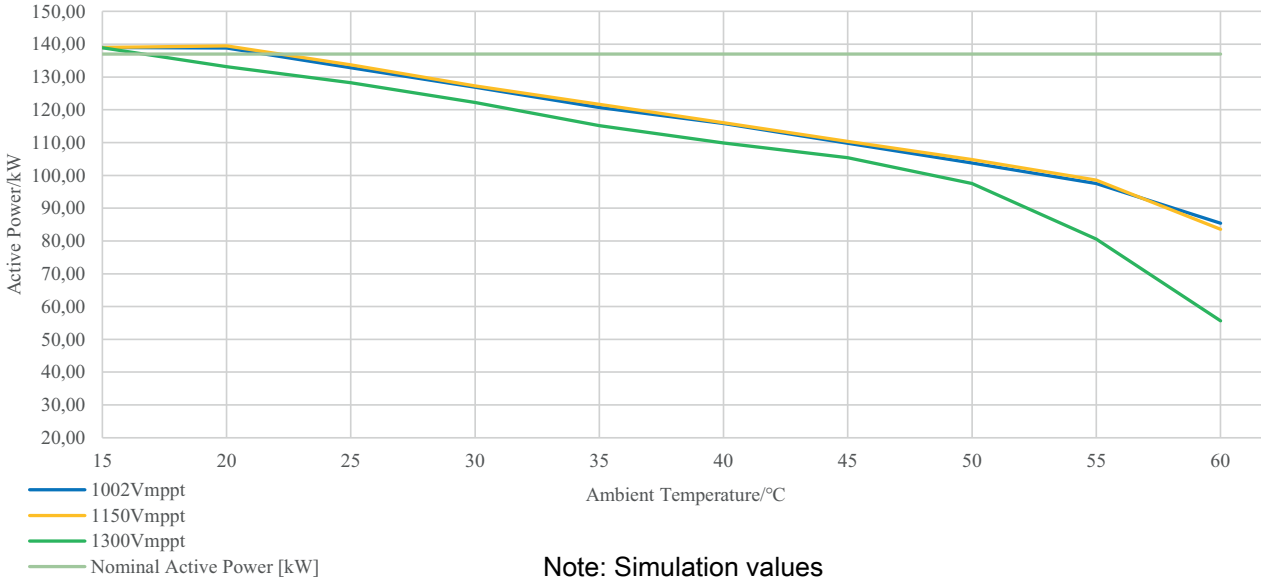
Note: Simulation values

Fig. 5: Mean value of active power at different temperatures with different DC voltages in charging mode – blueplanet gridsave 110 TL3-S



Note: Simulation values

Fig. 6: Mean value of active power at different temperatures with different DC voltages in charging mode – blueplanet gridsave 137TL3-S



Note: Simulation values

Fig. 7: Average value of active power at different temperatures with different DC voltages in discharge mode – blueplanet gridsave 137TL3-S

3.4 Selecting the device

The DC link capacitors of the device may be loaded with a current of no more than 300 A. To ensure that this is the case, pre-charging of the DC link is required prior to actual operation of the battery.

The chosen battery does not feature a precharge unit (PCU - precharge unit), then the device variants L and XL provide an integrated precharge unit that takes responsibility for the precharge stated above.

If the choice falls on a battery with integrated precharging unit, an M version device is sufficient. Please note the Equipment features [See section 3.4 Page 10], the function of precharge unit States [See section 5.4.1 Page 17] and the follwing warning.

⚠ CAUTION

Danger caused by exceeding the inrush current.

The device does not have a inrush current limiter on the DC side. Exceeding the maximum permissible inrush current of 300A can lead to destruction of the device.

› The inrush current must be limited to a max. current of 300A using external means. The DC input capacity of the device is approx 550µF.

› DC link may still be charged link after disconnecting the device from the battery. The limitation of the inrush current must also be ensured in this scenario.

› Failure to observe these instructions may result in damage to the device which is not covered by the warranty.

Device type	DC fuse at + F1	DC Precharge unit	DC switch at + K1	DC switch at - K3
blueplanet gs 92.0 -137TL3-S B1 WMODI-IGM	X	-	-	-
blueplanet gs 92.0 -137TL3-S B1 WMODIIGL	X	X	X	-
blueplanet gs 92.0 -137TL3-S B1 WMODI-IGX	X	X	X	X

Tab. 1: Equipment features

3.5 Selecting the location of the device

The devices are generally approved for outdoor use. Particularly when used in confined spaces, care must be taken to ensure suitable heat dissipation. The minimum distances specified in chapter 6.3 of the device manual ensure operation up to an ambient temperature of 40°C.

If it is necessary, the distances can be selected smaller, provided that the overall system can dissipate the device power loss(s) and ambient temperature (temperature in the immediate vicinity of the housing + airflow temperature) of <=40°C is ensured. If this is not given, the device goes into a power derating.

There are 3 fans installed in the device, which generate a maximum airflow of 364 m^3/h in total.

Additionally, the following characteristic maps for the efficiency to determine the heat dissipation of the device at certain points of operation.

NOTE: The consumer counter arrow system was used for the efficiency measurements.

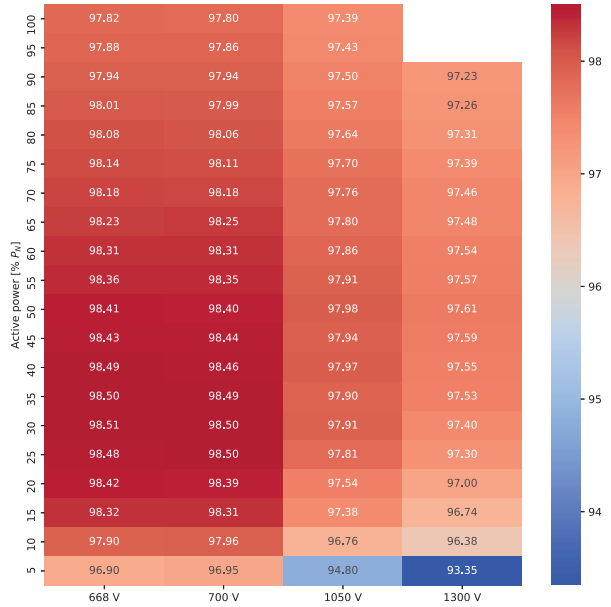


Fig. 8: Efficiency during charging (gridsave 92.0TL3-S)

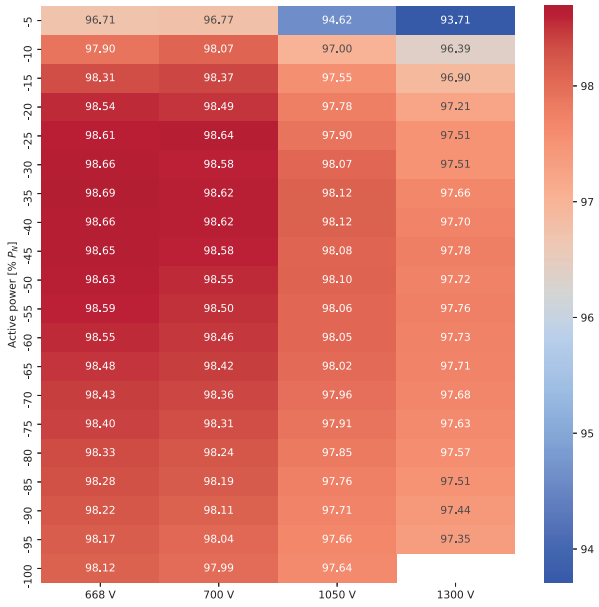


Fig. 11: Discharge efficiency (gridsave 92.0TL3-S)

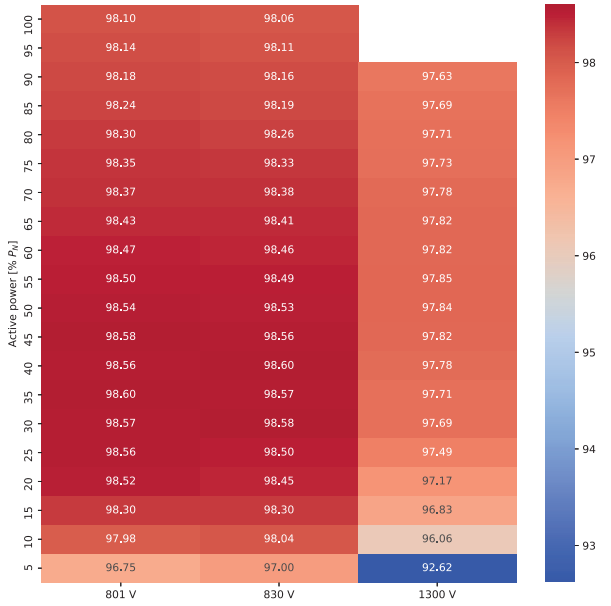


Fig. 9: Efficiency during charging (gridsave 110TL3-S)

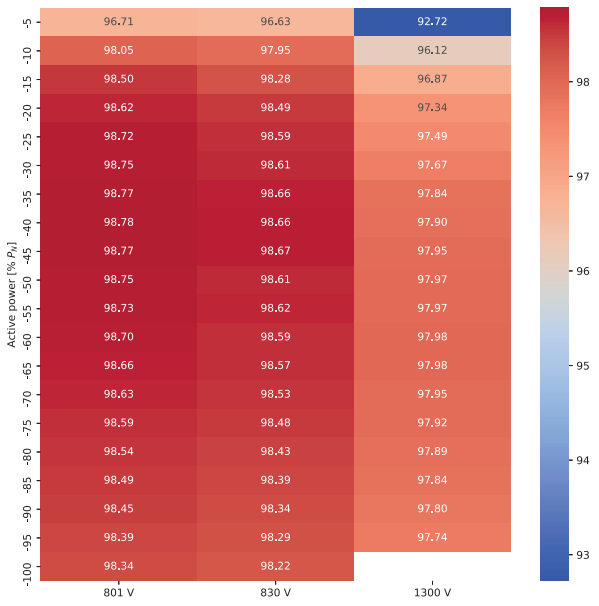


Fig. 12: Discharge efficiency (gridsave 110TL3-S)

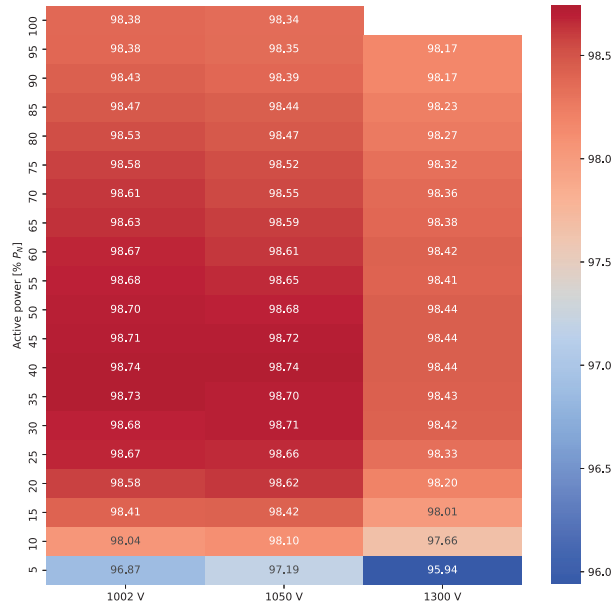


Fig. 10: Efficiency during charging (gridsave 137TL3-S)

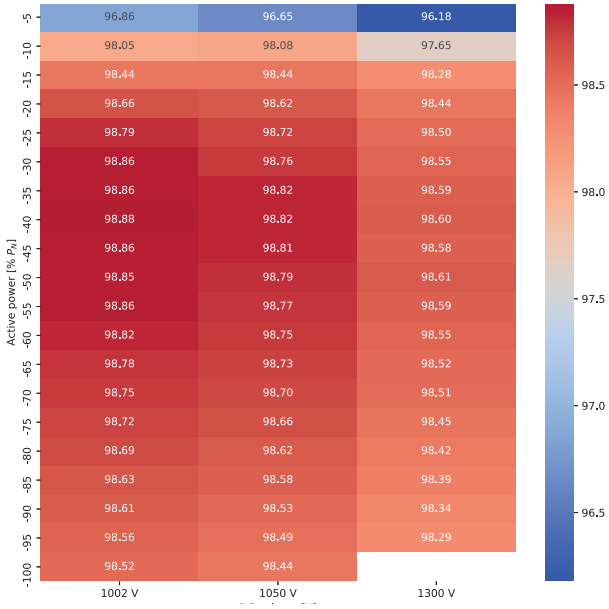


Fig. 13: Discharge efficiency (gridsave 137TL3-S)

NOTE

The system integrator is responsible for the design and validation of the overall system using the derating procedure. Contingency measures are used to prevent device malfunctions caused by a failure to observe minimum clearances. The device protects itself by means of an appropriate power derating

4 Technical data

4.1 Electrical data

	92.0 TL3-S	110 TL3-S	137 TL3-S
DC Input data			
Working range [2]	668-1,315 V	801-1,315 V	1002-1,315 V
Max. DC voltage [2]	1315 V		
Starting voltage	668 V	801 V	1,002 V
Max. input current	145 A		
Max. short-circuit current (ISC max.)	300 A		
Polarity safeguard	option / with PCU yes		
String fuse	M yes / L yes / XL yes		
DC- fuse holder	no		
DC+ fuse holder	Optional		
Number of strings	1		

	92.0 TL3-S	110 TL3-S	137 TL3-S
AC Output data			
Nominal power	92 kVA	110 kVA	137 kVA
Nominal voltage	400 V (3P+PE)	480 V (3P+PE)	600 V (3P+PE)
Voltage range: continuous operation	300 V - 580 V		480 V - 760 V
Max. voltage range (up to 100 s)	625 V		825 V
Nominal current	3 x 132.3 A		
Max. continuous current	3 x 132.3 A		
Contribution to peak short-circuit current ip	193 A		
Initial short-circuit alternating current (Ik” first single-period effective value)	137 A		
Short circuit current continuous (max output fault current)	134 A		
Inrush current	5 A [RMS (20ms)]		
Nominal frequency	50/60 Hz		
Frequency range	45 - 65 Hz		
Reactive power	0-100 % Snom		
cos phi	0.3 - 1 ind/cap		
Number of feed-in phases	3		
Distortion factor (THD)	< 3 %		%
AC overvoltage protection (Type)	Base		

[2] For country setting UD and IL, the working range can be increased to 1450 V. [see manual- in chapter: Menu structure].

4.2 General data

	92.0 TL3-S	110 TL3-S	137 TL3-S
General data			
Display	LEDs		
Control elements	Button / web server		
Menu languages	EN; DE; FR; IT; ES; PL; NL; PT; CZ; HU; SL; TR; RO; JP		
Interfaces	2 x Ethernet, INV OFF, Error-Relais (30V potential free contact)		
Communication	TCP/IP, Modbus TCP, based on Sunspec		
Fault signal relay	yes		
DC isolator switch	no		
AC isolator switch	no		
Cooling	Temp. controlled fan, max. air flow rate 364 m³/h		
Number of fans	3x outside, 1x inside		
Noise emission	<60 db(A)		
Housing material	AL		
HxWxD	719 mm x 699 mm x 450 mm		
Weight	78 (M); 81 (L); 82 (XL) kg		
Precharge unit	L + XL		
DC load relay +	L + XL		
DC load relay -	XL		
DC fuse	M + L + XL		
Max. power dissipation to room air	4 kW		
Safety	EN 62109-1, EN 62109-2		
Interference immunity/interference emission/grid feedback	EN 61000-6-2 / 62920 -Class A, EN55011 - Class A / EN61000-3-11, EN 61000-3-12		
*	Compliant with IEEE 1547a-2014 (Amd. 1)”		
Certifications	Overview: see homepage, download area		

	92.0 TL3-S	110 TL3-S	137 TL3-S
Max. efficiency	Charge 98.51 / discharge 98.69 %	Charge 98.6 / discharge 98.78 %	Charge 98.74 / discharge 98.89 %
Self consumption: Standby	< 8 / <14 with PCU Relay closed		
Transformer	no		
DC parallel operation	yes, 2		
Operating mode	Grid-dependent (charge/discharge)		
Battery type	All intrinsic battery types, e.g. lithium ions		
Protection class / over voltage category	I / III		
Clock frequency	48 kHz		
Grid monitoring	Country-specific		
Distribution system	TN-C system, TT system, Solid grounded wye		

4.3 Environmental data

	92.0 TL3-S	110 TL3-S	137 TL3-S
Installation height	3000m (derating from 2000m)		
Installation distance from coast	>500 m		

	92.0 TL3-S	110 TL3-S	137 TL3-S
Pollution level inside the enclosure	2 (reduced by IP 66 Housing)		
Pollution level outside the enclosure	3		
Ambient temperature	-20-+60 °C		
Protection rating (KACO installation location)	IP66 /NEMA 4X		
Humidity range (non-condensing) [%]	100		
Item number	1001912 (M) / 1001910 (L) / 1001911 (XL)	1002020 (M) / 1002021 (L) / 1002022 (XL)	1002014 (M) / 1002013 (L) / 1002012 (XL)
Name on name plate	BLUEPLANET GS 92.0 TL3-S B1 WM OD IIGL / BLUEPLANET GS 92.0 TL3-S B1 WM OD IIGM /BLUEPLANET GS 92.0 TL3 M1 WM OD IIGX	BLUEPLANET GS 110 TL3-S B1 WM OD II KM / BLUEPLANET GS 110 TL3-S B1 WM OD II KL / BLUEPLANET GS 110 TL3 M1 WM OD IIKX	BLUEPLANET GS 137 TL3-S B1 WM OD II PM / BLUEPLANET GS 137 TL3-S B1 WM OD IIPL / BLUEPLANET GS 137 TL3-S B1 WM OD IIPX

5 Specifications

5.1 Interfaces

NOTE

Protecting the KACO devices against remote access

› Kaco new energy devices do not feature a firewall. Create a safe device password. You can assign a separate password to each user range in the device's web user interface.

› For data security purposes, we recommend using a separate, protected network. KACO new energy does not accept any liability for damages resulting from failure to observe this advice, whatever the legal basis.

The block diagram shows internal and external communication interfaces of the device, for example.

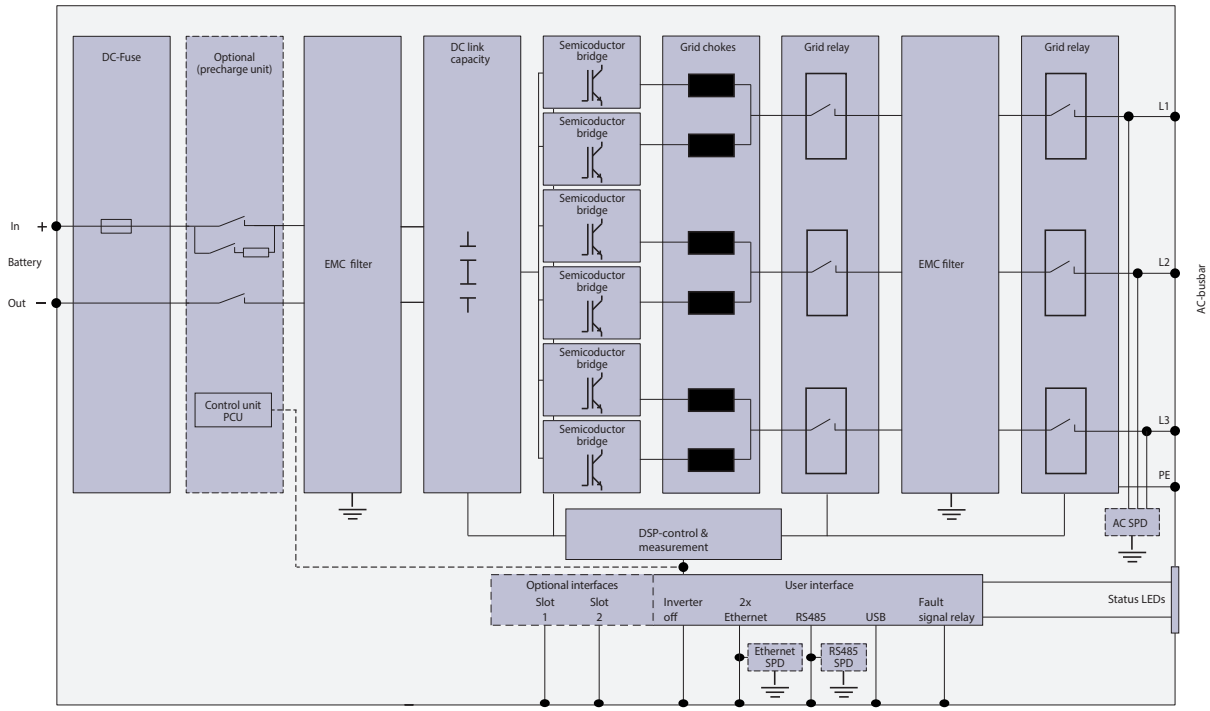


Fig. 14: Block diagram of the bi-directional feed-in inverter

The device uses an Ethernet interface for configuration and control.

Remote Access and Remote Update

The IP settings can be changed in the web interface. See specific parameters in the manual chapter Menu; and Configuration via web user interface

The default IP configuration is: DHCP

5.2 Device control

General

The device is controlled externally by a ModbusTCP interface which is based on SunSpec. We recommend to implement the SunSpec logic in your EMS. This one-time effort enables the dynamic addressing to reduce later efforts e.g. for device firmware updates and to avoid errors.

See the documents “SunSpec_Information_Model_Reference.xls” and “SunSpec_Information_Model_Reference_KACO.xls” which are provided together with this application note and the general SunSpec documentation for further information. More information [See section 1.3 Page 4]

Modbus registers are numbered from 1 to n. The data address in the Modbus protocol data unit (PDU, data on the wire) start from zero. For further information see Modbus Application Protocol V1.1b

http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

You can use the following Modbus function codes for all registers:

- FC03 (0x03) Read holding registers
- FC06 (0x06) Write single holding register
- FC16 (0x10) Write multiple holding registers

Write access (FC06 and FC16) to registers with access mode “R” (read-only) is possible and will not raise an error. The written value is ignored.

5.3 Device status

The following section describes various statuses that are relevant for integrating blueplanet gridsave devices into an EMS.

SunSpec device status (64201.RequestedState and 64201.CurrentState)

This is the only status that relates to management by the EMS and indicates the general operating status of the inverter. The states are described in greater detail in SunSpec device states [See section 5.4 Page 16].

PrologStatus (103.StVnd oder 64201.StVnd)

This is the detailed status of the device, which can be viewed on the web server.

It provides information on possible error causes during integration and in the event of service. For the actual operational management of the device by the EMS, this extensive status can be ignored. Details on individual statuses are described in chapter Prolog status messages [See section 7 Page 26].

Status of the optional precharging unit (64201.StPcu und 64201.ErrPcu)

The operating status or error status of the precharging unit, which has its own processor, can be queried here. A list of the PCU statuses can be found in the document SunSpec_information_Model_Reference_KACO im Model 64201.

5.4 SunSpec device states

The following diagrams shows the states and transitions of the device.

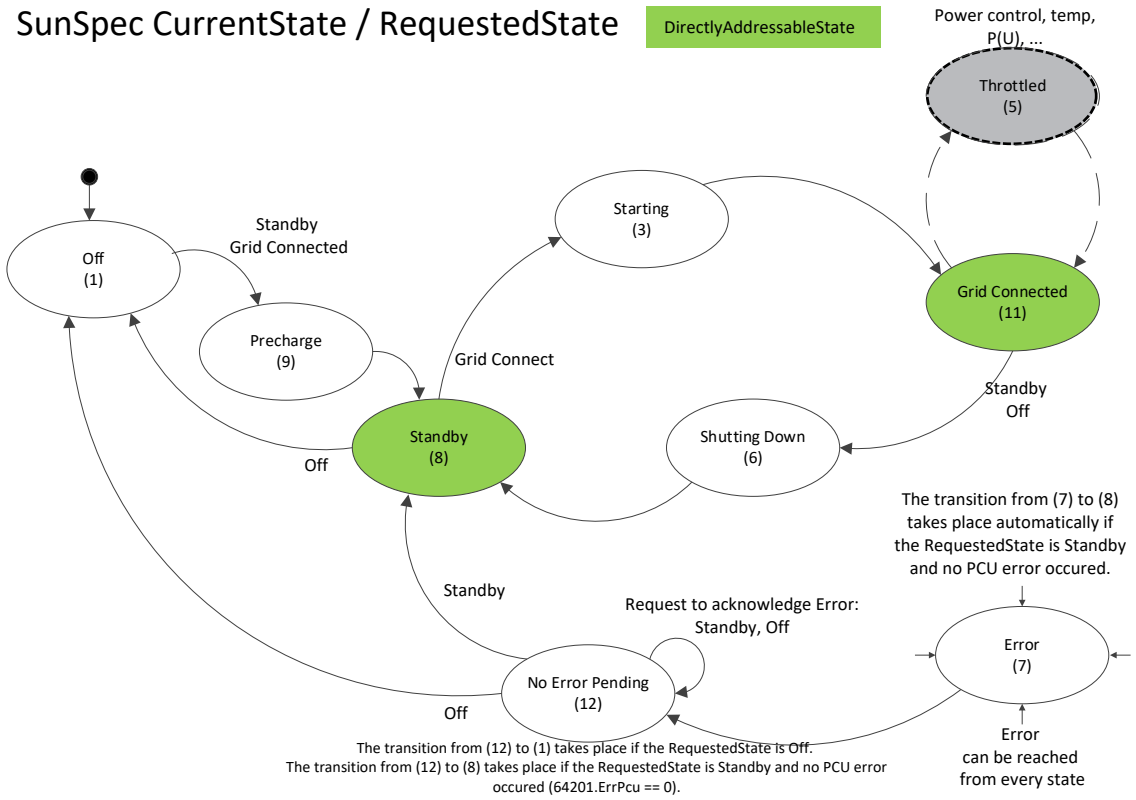


Fig. 15: Device states for devices with precharging unit

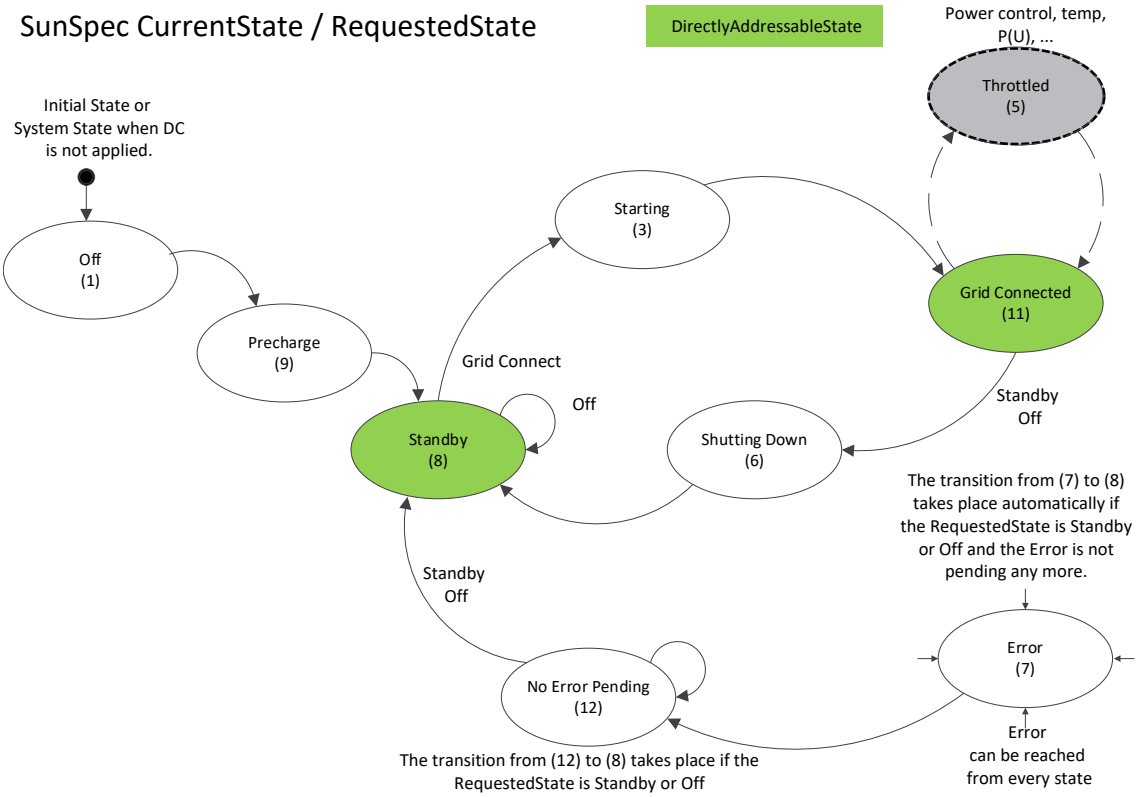


Fig. 16: Device states for devices without precharging unit

5.4.1 States

The following table shows the existing system statuses. There are Directly addressable statuses. These are possible target statuses for register 64201.RequestedState.

All other statuses cannot be reached directly, these are no possible target statuses for register: `64201.RequestedState`.

State	*State type*	Description
Off (1)	*Version L/XL:* Directly addressable state *Other Versions:* Other state	*AC-Relays and DC-Relay(s) (Version L/LX) disconnected* State is reached when AC is applied. The boot up time of the front end (HMI) takes about 105 seconds. The Modbus communication requires that AC is applied and that the front end (HMI) is booted. Modbus registers that contain measurement data will not contain meaningful values in this state (a read request will return 0). The battery limits must be sent at least once while in state Off (1) before starting the system / DC Link is charged. However, it is recommend sending the battery limits cyclically. The data point `64202.DisMinV` and `64202.ChaMaxV` must not be zero.
Standby (8)	Directly addressable state	*AC-Relays disconnects, DC-Relay(s) (Version L/LX) connected.* Power electronics is running, AC-grid and DC parameters are monitored (e.g. voltage, frequency).
GridConnected (11)	Directly addressable state	*AC-Relays and DC-Relay(s) (Version L/XL) connected.* Device is connected to the AD grid. Active power can now be set and take effect.
Precharge (9)	Other state Precharge process: States [See section 5.4.1 Page 17]	AC Relays disconnected, Precharge in progress. Transitional state in which the DC link is precharged and the controller of the power electronics is booting. After boot up state (8) is reached automatically. The precharge and boot time takes about 30 seconds. Modbus registers that contain measurement data will contain meaningful values after state (9) is left.
Starting (3)	Other state	*AC-Relays disconnected, DC-Relay(s) (Version L/XL) connected.* Transitional state in which the device waits for all values to be within its valid ranges and a stable AC grid is detected. Before connecting to the grid, a system self-test is invoked. The startup time depends on the country specific grid code (e.g. 60s for Germany 60s and 300s for South Korea country setting). The network monitoring time begins when the "Standby" status is reached (8).
Throttled (5)	Other state	*AC-Relays and DC-Relay(s) (Version L/XL) connected.* Device is connected to the AC grid. Output power is limited due to grid support functions or internal limitations (e.g. temperature derating).
ShuttingDown (6)	Other state	*AC-Relays and DC-Relay(s) (Version L/XL) connected.* Transitional state in which the device is disconnecting from the grid.
Error (7)	Other state	*AC-Relays disconnected and DC-Relay(s) (Version L/XL) state depends on the state of the PCU 64201.stPcu.* State can be reached from any other state in case an error is detected.
NoErrorPending (12)	Other state	*AC-Relays disconnected and DC-Relay(s) (Ver-sion L/XL) state depends on the state of the PCU 64201.stPcu.* State is reached when the device has switched off in case of an error (e.g. due to a network fault) and the error is not present any more. The error condition must be reset by requesting State Off (1).

Tab. 2: Possible target status for register

The precharging process is described below:

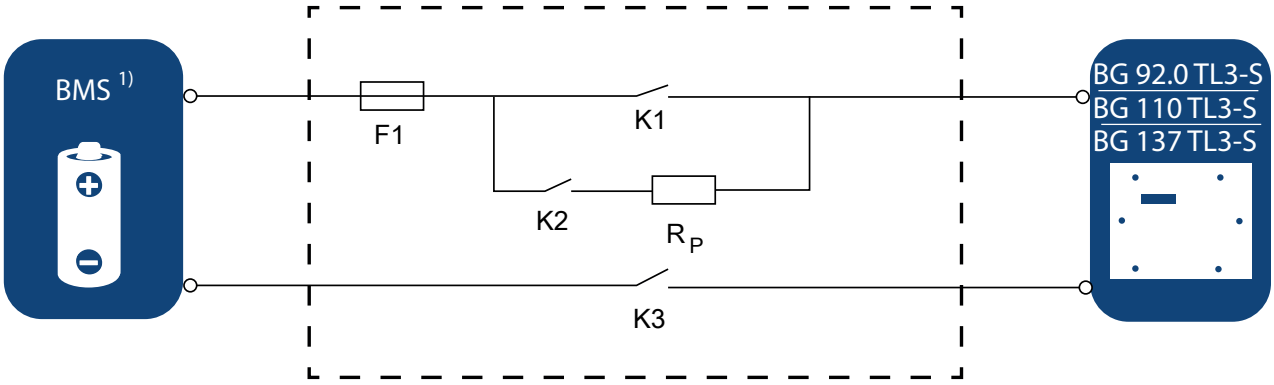


Fig. 17: Functional diagram of the precharge unit in the device

When the status changes from "Off" to "Standby", the precharging process works as follows:

- K3 closes (XL variant only)
- K2 closes -> DC link of the device is precharged via R_p.
- As soon as the DC link voltage = battery voltage -> K1 closes
- The precharging process is concluded when K2 opens
- Subsequent precharging is only possible after the cool down time (up to 240 s)

Component	Typ
Fuse F1:	Eaton PV-250A-2XL-3BU-15
Main Contactors K1 , K2:	Gigavac HX241-026
Precharge Resistor RP:	Frizlen GAND165x60

Tab. 3: Legend Prechargeunit

5.4.2 Recommended operating procedure

This chapter describes the recommended communication operation. The following steps should be performed to guarantee a working communication. To establish a Modbus connection, AC voltage must be present and the user interface must be fully powered up.

5.4.2.1 Mandatory register

At least the following registers are required for operation:

- Device connection state
  `64201.RequestedState` and `64201.CurrentState`
- Battery limits
  `64202.DisMinV`, `64202.DisMaxA`, `64202.ChaMaxV`, `64202.ChaMaxA` and `64202.EnLimit`
- External active power set point
  `64201.WSetPct`
- Watchdog control
  `64201.Watchdog`
- Reactive power mode (optionally to enable external reactive power control)
  `64201.ControlMode`
- External reactive power set point (optional)
  `64201.VarSetPct`

The following control value must be sent periodically (e.g. once every 1 second):

- Watchdog control
  `64201.Watchdog`

It is recommended that the following registers are sent periodically as well:

- Power set point
  `64201.WSetPct`
- External reactive power set point (optional)
  `64201.VarSetPct`

- Battery limits
  `64202.DisMinV, 64202.DisMaxA, 64202.ChaMaxV, 64202.ChaMaxA and 64202.EnLimit`

5.4.2.2 Operation

This chapter describes the recommended communication operation. The following steps should be performed in order to guarantee a working communication. AC must be applied and the boot up of the user interface must be completed in order to be able to establish a Modbus connection.

Step	Description	
	Version B and M (without precharge unit)	**Version L and XL (with precharge unit)**
1	Find the existing Modbus models and corresponding start addresses · Probe the well known bas addresses for the well known 32 bit “SunS”-Identifier. · Find all available SunSpec models and start addresses. · Calculate the absolute addresses of the registers that are used (See “address calculation example” in Application Note “Modbus-Procokoll”) · For details see document sunspace Information Model Specification.	
2	Check that all required models and data points are available For storage inverters at least the following models are required: · 1 (optional) · 121 · 64201 · 64202 **NOTE: The scale factors of all used data points must be read at least once. The data points must be scaled with the corresponding scale factors. Scale factors are not going to change during operation.**	
3	Recommended communication procedure The following models should be read once at the beginning (initial read sequence): · Read model 1 (optional) · Read model 121 The following models should be written at least once after startup: · Write model 64202 The following models should be read / written cyclically. · Read / write model 64201 · Read / write model 64202 (optional) **NOTE: Do not send more than 5 requests per second. The time between each request must be >= 200ms and should be equal.**	
4	Startup preparation · As long as the following steps are not completed at least once, the `64201.CurrentState` equals 7=ERROR. This error can be ignored. · Apply DC · Send valid battery limits: – Write model `64202` data point `DisMinV, DisMaxA, ChaMaxV, ChaMaxA, EnLimit` – `64202.DisMinV` and `64202.ChaMaxV` must not be zero. – `When 64202.EnLimit` is set to 1 the limits are activated. · Now `64201.CurrentState` will change depending on the device type:	
	· `64201.CurrentState`= 8	· `64201.CurrentState`= 1

Step	Description	
	Version B and M (without precharge unit)	Version L and XL (with precharge unit)
5	Start the device We assume that step 4 was processed and AC and DC voltage are applied.	
	• 64201.CurrentState is (8) • In order to start the device: – Set 64201.RequestedState register to 11 – 64201.CurrentState will change to (3)	• 64201.CurrentState is (1) • In order to start the device: – Set 64201.RequestedState register to 11 • The Intermediate circuit is precharged – 64201.CurrentState will change to (9) • After approx. 60 s the: – 64201.CurrentState will change from (9) over (8) to (3).
	• Device performs self-test and checks for a stable network. – 64201.CurrentState will change form (3) to (11). • The device is connected to the grid.	
	• In case of an error: – AC-Relays are opened – 64201.CurrentState will Change to (7). For further information see Prolog Status Read 64201.StVnd which described in chapter: Device status [See section 5.3 Page 15]	• In case of an error: – AC+DC Relays are opened – 64201.CurrentState will Change to (7). For further information see Prolog Status Read 64201.StVnd which described in chapter: Device status [See section 5.3 Page 15]
6	Send active power set points Register 64201.WSetPct is used for active power set points. • 64201.WSetPct should be 0 when 64201.CurrentState is not (11) or (5) • 64201.WSetPct should be 0 before 64201.RequestedState is set to (1) or (8) • 64201.WSetPct can be set as desired when 64201.CurrentState is (11) or (5) Optional: Send reactive power set points: To activate the reactive power setting: • set 64201.ControlMode register to 1 Register 64201.VarSetPct is used for reactive power set points. • 64201.VarSetPct should be 0 when 64201.CurrentState is not (11) or (5) • 64201.VarSetPct should be 0 before 64201.RequestedState is set to (1) or (8) • 64201.VarSetPct can be set as desired when 64201.CurrentState is (11) or (5) If desired, use register 64201.ControlMode to disable external reactive power control • set 64201.ControlMode register to 0	
7	Stop the device	
	• In order to stop the device: – Set 64201.RequenstedState register to 1	
	• Contactors are opened: – 64201.CurrentState will change over (1) to (8). – Note: (1) might not be visible.	• Contactors are opened. – 64201.CurrentState will change to (1)

Step	Description	
	Version B and M (without precharge unit)	Version L and XL (with precharge unit)
8	Clear error Error is not pending anymore and `64201.CurrentState` is (12).	
	· To acknowledge an error: – Set `64201 RequestedState` register to `1` – `64201.CurrentState` will change over (1) to (8) – Note: (1) might not be visible.	· To acknowledge an error: – Set `64201 RequestedState` register to 1 – `64201.CurrentState` will change to (1)

5.5 SunSpec register description

The following paragraphs describe the most common registers used to control the device. For a complete list of all registers pleased refer to the enclosed documentation ("*SunSpec_Information_Model_References.xls*", "*SunSpec_Information_Model_Reference_KACO.xls*" and the general SunSpec documentation).

NOTE: The model start addresses may change with each software release without notice. It is strongly recommended to calculate the model start addresses at each system start as explained in the SunSpec protocol description.

NOTE: The tool "Sunspec client light" can be used to read out the start addresses of the present SW version.

5.5.1 Model 121 - Basic settings

The following registers of Model 121 are needed to calculate the power setpoint (`64201.WetPct`) based on an absolute value. For a complete description of all registers present in Model 121 refer to SunSpec_Information_Model_Reference.xlsx.

SunsSpec model 121 – Basic Settings						
Name	Address Offset	Acc. Mode	Type	Unit	Scale factor	Description
`WMax`	2	R	Uint16	W	WMax_SF	Maximum power output
`WMax_SF`	22	R	Int16	-	-	Scale factor active power

5.5.2 Model 64201 - Device control

The following registers in `SunSpec model 64201` are used to control the inverter: For a complete description of all registers present in `Model 64201` refer to SunSpec-Information-Model-Reference-Kaco.xlsx.

SunsSpec model 64201 – Bidirectional inverter control						
Name	Address Offset	Acc. Mode	Type	Unit	Scale factor	Description
`RequestedState`	4	R/W	uint16	-	-	Requested device status: · 1 Off · 8 Standby · 11 Grid Connected
`CurrentState`	5	R	uint16	-	-	current state of the inverter
`ControlMode`	6	R/W	uint16	-	-	Power control mode 0 external P setpoint (`64201.WSetPct`), automatic Q control (as required by grid code) 1 external P and Q setpoint from EMS
`Watchdog`	8	R/W	uint16	Sec	-	Enable Watchdog timer. Register must be written with the desired watchdog timeout in seconds. 0 means watchdog is disabled.
`WSetPct`	9	R/W	`Int16`	`%Wmax`	`WSetPct_SF`	Active power setpoint in % of `WMax` See model 121 data point `Wmax`

SunSpec model 64201 – Bidirectional inverter control						
Name	Address Offset	Acc. Mode	Type	Unit	Scale factor	Description
VarSet-Pct	10	R/W	Int16	%Wmax	VarSet-Pct_SF	Reactive power setpoint in % of WMax. See model 121 data point WMax.
WSet-Pct_SF	46	R	Int16	-	-	Active power factor
VarSet-Pct_SF	47	R	Int16	-	-	Reactive power factor

a) Current device status

Register 64201.CurrentState contains the current state of the device. The number read from the register corresponds to the state shown in [See figure 16] [▶ Page 16] and [See figure 15] [▶ Page 16] above.

The device state can be changed by writing the desired target state to register 64201.RequestedState.

c) Capacity control

Active Power

Register 64201.WsetPct is used to control the active power set point. The value needs to be scaled with the corresponding scaling factor. Positive values of active power means discharging battery.

Example to calculate the register 64201.WSetPct in order to set the desired active power setpoint WSet_inWatt given in watt:

Reactive Power

The reactive power control mode can be switched between.

- automatic calculation of reactive power setpoints based on the selected gridcode (e.g. VDE AR-N 4105:2011) and interal parameters (see [1] and [2] how to configure the different internal reactive power control modes) and
- immediate reactive power control by direct is used to control the active power set point. The value needs to be scaled with the corresponding scaling factor. Positive values of active power means discharging.

In order to activate

- automatic calculation of reactive power
  - set 64201.ControlMode to 0
- immediate control of reactive power
  - set 64201.ControlMode to 1

Register 64201.VarSetPct is used to control the immediate reactive power set point. The value needs to be scaled with the corresponding scaling factor. Positive values of reactive power means overexcited operation.

Example to calculate the register 64201.VarSetPct in order to set the desired reactive power setpoint VarSet_inVar given in Var:

5.5.3 Model 64202 - Battery limits

All voltage and all current values must be scaled with the corresponding scaling factor V_SF or A_SF. For a complete description of all registers in Model 64202 refer to SunSpec_Information_Model_Reference_Kaco.xlsx

SunSpec model 64202 – Battery limits						
Name	Address Offset	Acc. Mode	Type	Unit	Scale factor	Description
V_SF	6	R	int16	-	-	voltage scaling
A_SF	7	R	int16	-	-	current scaling
DisMinV	8	R/W	uint16	V	V_SF	min. discharge voltage
DisMaxA	9	R/W	uint16	A	A_SF	max. discharge current
ChaMaxV	11	R/W	uint16	V	V_SF	max. charge voltage
ChaMaxA	12	R/W	uint16	A	A_SF	max. charge current

SunSpec model 64202 – Battery limits						
EnLimit	15	R/W	uint16	-	-	new battery limits are activated when EnLimit is 1

For increased efficiency it is recommended to write the registers DisMinV up to EnLimit in a single Modbus request (function code 16).

5.6 Model 64302 - General commands

For a complete description of all registers present in Model 64302 refer to SunSpec_Information_Model_Reference_Kaco.xlsx

SunSpec model 64302 – Generic commands						
Name	Address Offset	Acc. Mode	Type	Unit	Scale factor	Description
CommandIdReq	12	R/W	int16	-	-	ID of the command to execute 0 no command 1 Reset System
ReqParam0	13	R/W	uint32	-	-	first Parameter
CommandIdReqEna	29	R/W	uint16	-	-	writing a “1” triggers execution of command
CommandIdRes	30	R	int16	-	-	command ID response
ReturnCode	31	R	int16	-	-	status and result of command execution • 0 Success • 1 Processing • 2 unknown command • 3 error • 4 invalid parameter

To initiate a manual system reset perform the following steps:

- stop the battery inverter
  - set 64201.RequestedState to 1
  - Version B / M
    64201.CurrentState will change over (1) to (8).
  - Version L / XL
    64201.CurrentState will change to (1).
- prepare reset command
  - set 64302.CommandIdReq to 1 (“Reset System”)
  - set 64302.ReqParam0 to 0 (“Reset complete system”)
- execute command
  - set 64302.CommandIdReqEna to 1
- optionally check result by reading 64302.CommandIdRes and 64302.ReturnCode

6 Information on device behaviour

This chapter describes device behaviour that was not addressed in previous chapters.

6.1 Response times

The time it takes for a target value specified by the EMS to be implemented depends on the status of the device (“Off” / “Standby” / “Grid Connected”) and which parameters are active.

According to the graph shown below, the times are as follows:

- the amount of time that passes from status "off"(1) until the power specification is implemented is approximately: 60 s + any additional periods of time for grid monitoring prior to connection prescribed in the applicable grid guidelines.

- the amount of time that passes from status "Standby" (8) until the power specifications are implemented is approximately: 30 s + any additional periods of time for grid monitoring prior to connection prescribed in the applicable grid guidelines.
- In the "Grid connected" state (11), the time for controlling an external setpoint is composed as follows:

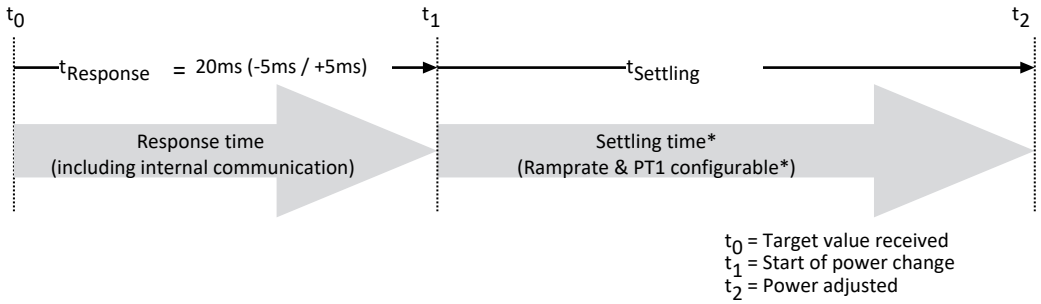


Fig. 18: Settling time for external set values prescribed by the EMS

*) The settling time is configurable and thus dependent on the parameterization of the ramprate (64201.WparamRmpDecTmm 64201.WparamRmpIncTmm)and the low pass filter (64201.WparamRmpTms).

*) For PT1 the 5tau are to be set.

You are able to limit the rampup via the EMS Modell 64201 and set the period of time until the power level is adjusted by altering the settings for PT1 response.

Factory default parameters:

- 64201.WparamRmpTms: 1.000 sec *
- 64201 WparamRmpDecTmm: 65534% $^{Ref\_Wert}/_{min}$
- 64201.WparamRmpIncTmm: 65534% $^{Ref\_Wert}/_{min}$
- 64201.VarParamRmpTms: 1.000 sec*
- 64201 VarParamRmpDecTmm: 65534% $^{Ref\_Wert}/_{min}$
- 64201.VarParamRmpIncTmm: 65534% $^{Ref\_Wert}/_{min}$

This would mean:

RmpDecTmm / RmpIncTmm=65534 => ramp is deactivated

WparamRmpTms = 1s => 5tau=1s. The time that is set is the settling time 5tau (5tau corresponds to 99.3% of the final value (in case of a start-up or 0.7% in case of a return)

NOTE: In model 64201, 5 tau are preset. At 0 sec, the PT1 filter is deactivated.

6.2 Response when battery limits are reached

If the end-of-charge or end point voltage is reached, the regulator reduces the active power in order to adhere to the voltage limit. During the charging process, the charge current is reduced, if necessary, to the point that the sign of the change current is inverted. The device behaves in the same way during the discharge process. If necessary, the discharge current switches over to a low charging current.

The device switches to the status “Throttled” (5) and the HMI reports the prolog status (222) “Discharge limits reached” or “Charge limits reached” (223). Prolog status messages [See section 7 Page 26]

6.3 Behaviour of the device in the event of battery shutdown

Because the DC link slowly discharges when the device is shut down, fault messages (DC voltage too low or similar) that can be ignored may appear.

If the external DC contactor or DC Switch connecting the battery to the battery inverter is interrupted by the operator or by the BMS of the battery system, the inverter will not automatically detect this event. However, battery inverter will remain connected to the AC connection point. In such case the battery Inverter cannot charge or discharge the battery any more. Instead, the DC-Link voltage of the inverter will increase to the MaxChargeVoltage very quickly or discharge the DC link voltage to the MaxChargeVoltage very quickly or discharge the DC link voltage to the MinDisChargeVoltage that was previously sent by the EMS as the battery limits.

6.4 Expanded DC voltage range

In the event that the DC voltage of the battery (e.g. due to self-discharge) drops to a voltage below the Start voltage (U_{D-Cmin}) the implemented extended DC voltage range can be temporarily activated to charge the insufficient battery voltage to the required voltage.

The activation is described in the manual of the device.

6.5 Connection following a grid error

NOTE: The EMS is responsible for adhering to the grid guidelines

Some grid guidelines make a distinction between connection following a grid error and connection under normal operation. This has an impact in terms of the different requirements for the following grid parameters / functions:

- Grid monitoring time
- Power rampup after connection
- Minimum and maximum switch-on voltage
- Minimum and maximum switch-on frequency
- When it comes to L and XL variant devices, it is not possible to distinguish clearly between connection following a grid error and connection under normal operation.

We can offer you two possible solutions for this:

1. The difference between the connection occurring after a grid error or as part of normal operation concerns the customer EMS. If the connection occurs after a grid error (decision-making criterion: fault status of the device, this status must be actively reset by the customer EMS), the waiting time after grid failure that is stipulated by the relevant standards must be observed before connection takes place (e.g. 600s in VDE-AR-N 4110).
2. The difference between the connection occurring after a grid error or as part of normal operation concerns the customer EMS. If the connection occurs after a grid error (decision-making criterion: fault status of the device, this status must be actively reset by the customer EMS), the customer EMS must ensure that the power rampup stipulated by the relevant standards is observed.

Country setting	Grid monitoring time after grid error by EMS	Rampup after grid failure by EMS
DE-NS2011	-	YES
DE-NS2018	-	YES
DE-4110	YES	-
AT	-	YES
FR-VFR14	-	-
IT-CEI016	-	-
IT-CEI021	-	-

Tab. 4: Affected country settings

6.6 Smart device functions

This chapter describes smart device functions offered by the device in order to, in particular, meet the requirements stipulated in the grid connection guidelines of grid operators without these requirements having to be taken into account in the EMS.

The availability or the adaptability of the functions may be limited depending on the country setting selected. (See Chapter 9.3.1 - menu in main chapter 9, the menu entry: Parameters in the device manual)
This is particularly true if the applicable grid connection guidelines make this restriction compulsory.

A detailed description of the functions and their parametrisation are provided in the device manual. (See Chapters 9 and 10 of the device manual)

In addition, the device provides pre-configured country settings that meet the requirements of certain grid guidelines.

6.6.1 Regulating active power

Dynamics / accuracy

In all of the control methods described below the specified target value at the inverter's connection terminals is adjusted using a stationary deviation of the reactive power of maximum 2%$_N$ SN.

The transient response of the control methods is determined by a PT-1 filter. In this case, the settling time corresponds to 5 Tau, or in other words, achieving approx. 99% of the final value for a PT-1 filter. Subject to the control method selected, there are also other parameters that determine dynamic behaviour.

6.6.2 Reactive power control

Reactive power can be used in electrical energy supply networks to bolster the level of voltage. As such, feed-in inverters can contribute to statistical voltage stability. Reactive power brings about a voltage drop at the inductive and capacitive components of the equipment which can either bolster or reduce the level of voltage. If the generating plant draws inductive reactive power while active power is being fed in, part of the voltage swing caused by the active power feed can be compensated for by the supply of reactive power.

This reactive power mode and the respective control process are specified by the grid operator. If no control process has been specified, then the plant should be operated using a reactive power specification of 0%.

6.6.3 FRT

Dynamic grid support (Fault Ride Through)

A generator plant's ability to remain immune to voltage drops and voltage spikes in the supply system is a key element in establishing a reliable energy supply. Immunity to interference ensures that brief disruptions do not result in a loss of generation capacity in a larger range of an interconnected grid. Grid support by a fast feeding of residual current also limits the spatial extent of the incident.

With its dynamic grid support by way of immunity, the device has this characteristic. The ability to remain on the grid is particularly relevant. The protective settings also determine the device's ability to remain on the grid or not. Protective settings take the upper hand over the capacity of immunity to interference.

7 Prolog status messages

The following table lists the possible ProLog© status messages that the device can display by means of the LC display / web user interface and the LEDs.

B = Operator's responsibility ; E = The indicated work may only be carried out by an authorised electrician. ; K = The indicated work may only be carried out by a service employee of KACO new energy GmbH!

No.	Result message	Explanation	Remedy	Pers.
1	Waiting for feed-in	MMessage is displayed when the device is started. The battery voltage is lower than the starting voltage (pre)set in the device or the mains is still being checked for stability.	Check if the start voltage was set too high in the menu. - If applicable, reduce the start voltage.	-
2	Insufficient generator voltage / insufficient battery voltage	Insufficient battery voltage and power. Status before transition from or into standby.	> Does the web interface display the voltage measured at the DC terminals correctly? => If necessary, check string tension individually. > Is the DC disconnector (WL version) switched off? => Switch off the DC disconnector > If the DC polarity is reversed? => Pol	B
4	Yield counter for daily and annual yields are displayed	Message indicates regular charging/discharging on the battery	0	E
8	Self-test in progress	Self-test of the relay, inspection of grid relay before feed-in commences. Should only be regarded as an error if one of the self-test routines gets stuck. During the self-test before grid feed-in, the following sequence is run through: 1. S8 grid relay self-test 2. S79 ISO measurement 3. S8 filter relay self-test 4. S75 (load DC link) 5. S8 pre-synchronization 6. S4 feed-in	If the device continues to have this status over a long period despite there being sufficient DC voltage, this indicates the presence of a fault in the device.	-

No.	Result message	Explanation	Remedy	Pers.
10	Temperature in unit too high	The device was switched off due to overheating caused by lack of air circulation.	Were the minimum clearances for installation on the other side observed? => Check information in chapter 6. Was the device accidentally covered? =>Remove object or cool off the area. Is the fan or, if accessible, the heat sink contaminated? => Clean fan & heat sink according to chapter 11.2.	B B E
11		The control board temperature is too high. This is a protective function that prevents damage caused by excessively high temperatures.	see Status 8 in Remedy	-
17	"Powador-protect disconnection" or "External grid protection shutdown"	Due to a grid fault (e.g. under/overvoltage or under/overfrequency), a shutdown has been initiated by the higher level grid system protection. Set limit value was exceeded.	> Has the grid plant protection been supplied with power correctly? => Check the “grid parameters” on the grid plant protection. (external device) > Is the cabling routed correctly? => If external grid plant protection is not needed, it must be deactivated in the menu of the device. See chapter 9.4 “Menu structure”.	E
20	Power rampup active	Internal power limitation e.g.: “Ramp Up" 10 %/min The result when the power is increased with a ramp is country-specific (after P(f), restart, after grid error, after every connect)	This is required in the country-specific standard.	-
33	DC feed-in error	The DC proportion of the feed-in current is outside the permissible limit values.	When this is shown once, the system attempts a recalibration. When this is shown frequently or continuously, contact Service. Note: Because of the country-specific specification (e.g., Italy), the limit values for switching off are very low.	E
34	Internal communication error	A communication error has occurred in the internal data transmission.	If an installation technician is on site, the communication cable between the display board and the AC power unit should be checked for secure fit or a conventional CAT5 cable should be used for the check. Note: A high-temperature-proof cable is prescribed for use in the device. Please contact Service.	E
35	Protection shutdown SW	On account of a measured value that lies outside the permissible range, a shutdown has been performed to protect the device	> Does the fault only occur sporadically? => Initiate device restart (AC+DC disconnection). > How is the device connected on the grid end (heavily inductive grid (on the transformer itself))? => If the system has its own transformer, the short-circuit voltage of the transformer provides information on the inductance of the grid for the system If the error is present continuously, check all terminals from the device through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem. Otherwise, contact Service.	K

No.	Result message	Explanation	Remedy	Pers.
36	Protection shutdown HW	Group message for all trip zone shutdowns.	Grid-related shutdown of the grid operator. The grid reconnects automatically. Please wait...	-
37	Unknown hardware	No valid version of the power unit was detected.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	-
38	Error: Generator Voltage too high Error: Battery overvoltage	The voltage of the battery is too high.	Check the battery voltage with a suitable measurement device. Are batteries switched in series? Check the permissible voltage range [See chapter: Technical data]	E
41	Grid failure undervoltage L1	The limit value is country-dependent. This is a legally required check of the network supplier.	Your solar installer must check the AC voltage at the terminals and AC wiring. If the settings in the menu are also correct, contact Service.	E
42	Grid failure overvoltage L1	See explanation in Status 41	See remedy in Status 41	E
43	Grid failure undervoltage L2	See explanation in Status 41	See remedy in Status 41	E
44	Grid failure overvoltage L2	See explanation in Status 41	See remedy in Status 41	E
45	Grid failure undervoltage L3	See explanation in Status 41	See remedy in Status 41	E
46	Grid failure overvoltage L3	See explanation in Status 41	See remedy in Status 41	E
47	Grid failure phase-to-phase voltage	The phase angle between the individual phases of the three-phase supply network is not correct, possibly no three phase connection.	> Can your solar installer check all connection terminals from the device through to the grid connection? => A fluctuating or missing AC voltage can indicate this connection problem. If applicable, compare to the country-specific limitation and check the settings in the menu Have the AC fuses been checked? => Missing phase can cause message. > Are the 4 software specifications (ARM application?; CFG? ; DSP-AC?; DSP-DC?) according to the package size identical? => An error in the unzipping process causes the display of a shutdown voltage of 110V and this can result in error S47. Following a correct firmware update, the device should work	B/K
48	Grid failure underfrequency	Measured value for grid frequency lies outside the permitted limit. Limit is country-specific.	Is the country setting correct? => Check setting values in the parameters menu. Your solar installer should check the AC connection and the connection to the device. Otherwise, contact Service.	E
49	Grid failure overfrequency	See explanation in Status 48	See remedy in Status 48	E
50	Grid failure average voltage	The grid voltage measurement according to EN 50160 (10 min. mean value) has exceeded the maximum permitted limit value.	In case of frequent occurrence, check the settings in the menu. > If applicable, was the firmware installed incorrectly? => Unpack firmware according to instructions in the download area.	E

No.	Result message	Explanation	Remedy	Pers.
56	SPI Remote shutdown	Remote-controlled shutdown by digital input. (e.g., CEI 0-21)	This was caused by the grid operator.	-
57	Waiting for reactivation	The waiting time following a fault is country-specific and can take several minutes.	Does the message appear frequently? => Find out the reason for the shutdown via error logs, Prolog status	-
58	Control board overtemp.	The temperature inside the device was too high. The device shuts down to avoid hardware damage.	This message only appears at high ambient temperatures (<60°C) > Has the power been checked? => Observe derating temperature according to data sheet > Is the fan or heat sink covered? => Clean device according to chapter 11.2.	E
59	Self-test error	A fault occurred during a self-test.	Switch off the device entirely (switch off AC + DC for min. 5 minutes) to ensure that the capacitors are discharged; if the fault occurs again, there is a device fault.	E
60	Generator voltage too high Battery voltage too high	The inverter does not begin feeding into the grid until the battery voltage falls below a specified value.	Check battery voltage with a suitable measuring device.	-
61	External limit x%	The grid operator requires an active power reduction. This is not a fault message, it is a status message. If only reactive power is specified, this status is not displayed.	This is a requirement of the grid operator.	-
63	Frequency-dependent power change	The feed-in power is changed linearly over a certain frequency value (P(f): Frequency-dependent power change). This requirement is country-dependent. The response can be configured. Normative requirements. No indication on display (behaves in the same way as normal feed-in mode status 4, therefore no flashing "Feed-in" LED). Can be viewed in service log files and via proLOG/portal. When certain country settings are activated, the frequency-dependent power change is activated.	This is a normative requirement.	-
64	Output current limiting	Power limitation because the max. permissible value for the feed-in current per phase has been reached. This is a protective function of the device. The AC current is limited once the specified maximum value has been reached.	This is a normal safety function of the inverter.	-
70	Fault in fan 1	The fan is malfunctioning.	Is the fan dirty or does it not start? => Service the fan according to chapter 11.	E
71	Fault in fan 2	See explanation in Status 70	See remedy in Status 70	E
72	Fault in fan 3	See explanation in Status 70	See remedy in Status 70	E
73	Standalone grid error	Standalone mode was detected.	Device was shutdown in PV system after event. Contact Service.	B
75	Self-test in progress	No fault message, only a status. Entire self-test sequence is documented in S8.	N/A	-

No.	Result message	Explanation	Remedy	Pers.
81	Protect. shutdown grid volt. L1	Protection shutdown due to an excessively high grid voltage It is the live value which is decisive for the shutdown. As such, a single peak value is enough to cause a shutdown.	Does the message appear frequently? => The solar installer must check the installation and contact Service, if applicable.	E
82	Protect. shutdown grid volt. L2	See explanation in Status 81	See remedy in Status 81	E
83	Protect. shutdown grid volt. L3	See explanation in Status 81	See remedy in Status 81	E
84	Protection shutdown undervolt. DC link	Display when the min/max. value of the intermediate circuit voltage is not reached. If the device stops feeding in, then there is a fault in the device. Otherwise, a highly inductive grid is responsible for this.	Is the location on the Ac-side to the device correct? => Check all connection terminals from the device through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem. Note: Check the AC-side wiring (transformer inductance capacity) N-conductor is theoretically permitted to have reduced specifications.	E
85	Protect. shutdown overvolt. DC link	See explanation in Status 84	See remedy in Status 84	E
86	Protect. shutdown DC link asymmetry	Protection shutdown due to excessive asymmetry of the two DC link halves	Is the message present after restarting the feed-in? => Contact Service.	E
87	Protection shutdown overcurrent L1	Protection shutdown due to an excessive grid current.	Is the AC wiring correct? => The current measurement may be incorrect. Contact Service.	E
88	Protection shutdown overcurrent L2	See explanation in Status 87	See remedy in Status 87	E
89	Protection shutdown overcurrent L3	See explanation in Status 87	See remedy in Status 87	E
91	Protect. shutdown drop 2.5V	See explanation in Status 90	See remedy in Status 90	-
92	Protect. shutdown drop 1.5V	See explanation in Status 90	See remedy in Status 90	-
93	Buffer 1 self-test error	Error in the buffer test during the self-test – Automatic restart after 3 minutes	If this occurs repeatedly, contact Service.	E/K
97	Protection shutdown overcurrent HW	The protection shutdown has tripped due to an overcurrent to the grid. Triggered by a TripZone.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	E/K
100	Protect. shutdown HW overheating	Hardware protection shutdown due to overtemperature in the temperature sensor on the control board.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B E
101	Temperature plausibility error	The individual temperatures in the device are compared with one another. This fault occurs if a certain limit value is exceeded.	SW-Update>=2.37 (optimization in case of sporadic error)	K
104	Plausibility fault AFI module	N/A	N/A	K
105	Relay plausibility error	See explanation in Status 104	See remedy in Status 104	K
106	Plausibility error DCDC converter	See explanation in Status 104	See remedy in Status 104	K

No.	Result message	Explanation	Remedy	Pers.
108	Grid failure overvoltage L1	Device has detected a fault on one phase and was shut down.	Are the settings in the menu according to the grid voltage correct? => After the check, visually inspect all connection terminals from the device through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem.	E
109	Grid failure overvoltage L2	See explanation in Status 108	See remedy in Status 108	-
110	Grid failure overvoltage L3	See explanation in Status 108	See remedy in Status 108	-
111	Grid failure undervoltage L1	See explanation in Status 108	See remedy in Status 108	-
112	Grid failure undervoltage L2	See explanation in Status 108	See remedy in Status 108	-
113	Grid failure undervoltage L3	See explanation in Status 108	See remedy in Status 108	-
125	Relay control error	The enable signal for the relay control is read back.	If this occurs repeatedly, contact Service.	K
128	Internal memory error 1	Write or read access fault to the internal RAM.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
129	Power reduction P(U)	Message present if the function P(U) sets the power level according to the specified parameters subject to the AC voltage.	This function can be requested by the grid operator, for example. If a request is not present, the function can be deactivated.	B
148	Error external memory 1	The device has internal permanent memories to store the hardware that is used, for example. The parameters for the operation are derived from there.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
150	Protect. shutdown drop 1.65V	Internal protection function to maintain the required measuring accuracy.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
158	Power limitation	Power limitation because the internal temperature is too high. The temperature is measured on the control board. This is a protective function of the device.	Check if the device is cooled: Heat sink clean and installation instructions observed according to the manual (distances)?	-
159	Waiting for configuration	DSP is waiting for configuration data from the HMI.	The configuration of the device via the web user interface must be completely finished.	B
160	Error: Grid relay L1	The self-test detected a fault for the grid-side relay.	If this occurs repeatedly, contact Service.	-
161	Error: Grid relay L2	See explanation in Status 160	See remedy in Status 160	-
162	Error: Grid relay L3	See explanation in Status 160	See remedy in Status 160	-
163	Error: Grid relay N	N/A	N/A	-
164	Error: Filter relay L1	The self-test detected a fault for the relay in the device.	If this occurs repeatedly, contact Service.	-
165	Error: Filter relay L2	See explanation in Status 164	See remedy in Status 164	-
166	Error: Filter relay L3	See explanation in Status 164	See remedy in Status 164	-

No.	Result message	Explanation	Remedy	Pers.
172	Internal fan error	Failure of an interior fan or the corresponding tacho signal. The power is reduced to 50% Pnom. All 3 LEDs light up on the device.	Is the fan jammed? => If applicable, clean according to chapter “Maintenance”. For trained electricians: Are plugs connected correctly?	-
173	External fan error	Failure of an external fan or the corresponding tacho signal. The power is reduced to 50% Pnom. All 3 LEDs light up on the device.	See remedy in Status 172	-
180	Pre-synchronization not possible	Adequate voltage pre-synchronization with the AC grid not possible.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
184	Protect. shutdown overcurrent L1 int.	Protection shutdown due to overly high grid current in the interleaved path (channel B) on phase Lx. It is the live value which is decisive for the shutdown procedure.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	-
185	Protect. shutdown overcurrent L2 int.	See explanation in Status 184	See remedy in Status 184	-
186	Protect. shutdown overcurrent L3 int.	See explanation in Status 184	See remedy in Status 184	-
187	Fault in fan 4	Failure in the 3rd external fan or the corresponding tacho signal. The power is not reduced. This is done by way of temperature curtailment. All 3 LEDs light up on the device.	Is the fan jammed? => If applicable, clean according to chapter “Maintenance”. For trained electricians: Are plugs connected correctly?	E
188	Semiconductor test not possible	The measurement or actuation of the semiconductors failed. If applicable, the integrated AC filter can no longer be discharged below 50 V.	Make sure there is no grounding problem. Disconnect the device on the AC and DC side. Observe the wait time on the warning sign. Switch the device on again. If this message is displayed again, contact Service.	B
189	Semiconductor module 1 in channel A defective	Semiconductor module x in channel A is defective or the corresponding filter relay does not close correctly.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
190	Semiconductor module 2 in channel A defective	See explanation in Status 189	See remedy in Status 189	-
191	Semiconductor module 3 in channel A defective	See explanation in Status 189	See remedy in Status 189	-
192	Semiconductor module 1 in channel B defective	Semiconductor module x in channel B is defective or the corresponding filter relay does not close correctly.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	-
193	Semiconductor module 2 in channel B defective	See explanation in Status 191	See remedy in Status 191	-
194	Semiconductor module 3 in channel B defective	See explanation in Status 191	See remedy in Status 191	-

No.	Result message	Explanation	Remedy	Pers.
195	DESAT failure	The DESAT of the IGBTs has tripped or the power supply (24 V) of the gate drivers is too low. Usually occurs during feed-in!	If the error occurs continuously: Hardware defect of the power board -> Replacement of the device required. If the error occurs sporadically: SW-Update to v2.37 or later (if the error continues to occur sporadically over an extended period of time, the inverter must be replaced)	-
196	External communication error	A communication error or an interruption has occurred in the external data transmission between the inverter and the external controller. The DSP is supplied with DC voltage and the watchdog register (Sunspec 64201.Watchdog) is not written cyclically. For variants with PCU (L and XL), the error can only occur after precharging has taken place.	Check the function of the EMS. Error messages present in the external EMS? Check communication connection between EMS and inverter: 1) Check physical connection (network cable, switch, ...) 2) Check IP settings of EMS and inverter 3) Inverter "pinged" by EMS?	-
197	Symmetry error parallel connection	Circuit currents too high with two or more blueplanet gridsave devices connected in parallel.	N/A	-
198	Rapid shutdown of the PCU	Battery is disconnected from the device. Quick shutdown by internal or external PCU	If the battery is connected?	-
199	Battery limits not available	For operation, the battery limits (max. charging or discharging current, charging or discharging end voltage) must be transmitted to the blueplanet gridsave by the EMS.	Valid battery limits must be transmitted to the device via the EMS. Parameters in Sunspec model 64202. To accept the parameters, 64202.EnLimit = 1 must be set	-
203	Protect. shutdown grid volt. L1	Protective shutdown due to an excessively high grid voltage. It is the effective value which is decisive for the shutdown procedure.	Is the error displayed frequently? =>Check the installation again. Otherwise, contact Service. Note: Error can be caused by a poor location on the AC side. Check all connection terminals from the inverter through to the grid connection. A fluctuating or missing AC voltage can indicate this connection problem.	E
204	Protect. shutdown grid volt. L2	See explanation in Status 203	See remedy in Status 203	-
205	Protect. shutdown grid volt. L3	See explanation in Status 203	See remedy in Status 203	-
206	Protection shutdown overcurrent HW	AC overvoltage trip-off that was triggered by a hardware comparator.	-	-
207	Hardware detection failed: AC control card	The data saved on the control card is erroneous.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
208	Detection of hardware detection failed: AC power board	The data saved on the AC power board is erroneous.	See remedy in Status 207	B
209	Detection of hardware detection failed: AC relay board	The data saved on the AC relay board is erroneous.	See remedy in Status 207	B

No.	Result message	Explanation	Remedy	Pers.
215	Waiting for fault acknowledgment	Following an error, the error status in the device is not reset automatically. The error must be reset via the EMS.	The EMS must set the operating status to "1 - OFF" in order to reset the error (Sunspec 64201.RequestedState=1)	-
216	Protect. shutdown HW - overvoltage DC link halves	One of the two DC link halves has exceeded the maximum value. Shutdown occurs by way of HW-detection and TripZone shutdown.	Restart of the device attempted? (Disconnect AC/DC - switch it back on after 5 minutes.) => If unsuccessful, contact Service.	B
217	Protect. shutdown HW - 24V supply voltage	The supply voltage in the device has exceeded its max. permitted value. Shutdown occurs by way of HW-detection and TripZone shutdown.	See remedy in Status 216	B
218	Precharge unit fault	The precharge unit (PCU) has detected an error. Error details can be requested via the display or the EMS (Sunspec: 64201.ErrPcu). PCU Error [64201.ErrPcu]; 0 NO_ERROR No Error; 1 OVER_TEMP Over temperature; 2 OVER_VOLT Input voltage (DC) to high; 3 UNDER_VOLT Input voltage (DC) to low; 4 BATT_POL_INCORRECT Input voltage reverse polarity protection; 5 ERROR_COUNTER_TOO_HIGH Max. number of unsuccessful (ERROR_PRECHARGE) precharge tries exceeded Contact authorized service. Error can only be cleared by AC power cycling; 6 ERROR_PRECHARGE Precharge not successful; 7 ERROR_RUNNING_MODE Error during RUNNING mode; 8 I2C_COMM I2C communication error; 9 CAN_COMM CAN communication error; 10 EXT_EMC_SWITCHOFF External switch off, e.g. because of grid fault	The EMS must set the operating status to "1 - OFF" in order to reset the fault (Sunspec 64201.RequestedState=1)	-
219	Ready for precharging	Device is ready for operation, can be connected by the EMS : for devices with PCU always prior to connection	N/A	-
220	Precharge	Pre-charging of intermediate circuit, DSP starts. in the case of devices with PCU during precharging	N/A	-
221	Wait for cool down time	To protect against thermal overload, a cool down time of >300 s must be observed between each precharging process.	The start-up process is resumed once the cool down time has elapsed.	-
222	Discharge limits reached	The discharge capacity is reduced in order to adhere to the discharge limits (end point voltage and max. discharge current). To protect the battery against overloading (exceeding end-of-charge voltage: U_DC > Umincharge), a low-power discharge occurs automatically.	Check EMS. Reduce the discharge capacity or charge the battery	-

No.	Result message	Explanation	Remedy	Pers.
223	Charging limits reached	The charging capacity is reduced in order to adhere to the charging limits (end-of-charge voltage and max. charging current). To protect the battery against overloading (exceeding end-of-charge voltage: U_DC > Umincharge), a low-power discharge occurs automatically.	Check EMS. Reduce charging power or discharge battery	-
224	External limitation	This is a relative specification of the desired active power adjustment.	-	-
225	Battery voltage too low	If the battery voltage is too low in comparison to the AC voltage (e.g. <668V at 230Vac; -> Udc < Uac*2,91) then the device waits for 120 s + self-test time until the ratio of AC voltage to DC voltage returns to the permissible range. Once the waiting time elapses, the device switches to the fault status 225 („Batteryvoltage to low to connect to grid“).	Restart the device or, if applicable, start “Emergency charging”. [See description in chapter 5.4 Emergency charging and Activation in the manual, chapter: Configuration via web user interface]	-
226	Inverter is manually disconnected from the grid	The inverter can be disconnected from the grid manually after logging in via the WebGui or the button on the housing. This message then appears.	Activate the grid connection via the icon on the web user interface.	B
227	Protective shutdown current asymmetry	Protective shutdown that enables safe shutdown of the device in the event of (high-ohm) grid failures. Grid events can cause asymmetrical currents in the inverter. They are detected and shut down accordingly.	-	-
228	Protective shutdown voltage asymmetry	Protective shutdown that enables safe shutdown of the device in the event of (high-ohm) grid failures. Grid events can cause asymmetrical voltages in the inverter. They are detected and shut down accordingly.	-	-
229	DC voltage error	The error is triggered based on the battery limits, whereby the overvoltage is permanently stored in the PCU (1500 VDC). Reversed means that the battery is connected with reverse polarity. The group error comes from the PCU. The details can be read out via SunSpec 64201.	none	-
230	AC voltage limitation	This is a protective function of the device that allows it to be switched off quickly in case of incidents or switching operations at the medium voltage level.	none	-
231	External active power value	External specification of a setpoint value for the fed-in active power. The fed-in active power can be increased or decreased with the grid support procedure. Grid support procedures thereby have higher priority.	N/A	-
232	Protection shutdown neutral conductor current (live value)	N/A	N/A	-

No.	Result message	Explanation	Remedy	Pers.
233	Protection shutdown neutral conductor current (effective value)	N/A	N/A	-

NOTE

Event number not found?

Event numbers that are displayed in the device and not listed here generally require a service call by your installation partner.

NOTE

If an event occurs irregularly, our service technician needs to have the service package stored on the device. You must download and send this under the menu item “Service” – “Export Service Package”

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